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FINAL REPORT

PREDICTIVE MODEL FOR INTRA-GROUP NEGOTIATION

AF-AFOSR-62-314

FEBRUARY 1, 1962 TO JUNE 31, 1964

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PRINCIPAL INVESTIGATOR

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FINAL REPORT

PREDICTIVE MODEL FOR INTRA-GROUP NEGOTIATION

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The proposal that was the basis of the AFOSR grant had the following objectives:

1. To test the assumption of maximization of expected utility.
2. To test the assumption that the impact of a speech depends only on which proposal it endorses.
3. To test the assumption that each negotiator speaks with a fixed probability.
4. To design a model that deals with negotiations in which majority (rather than unanimous) agreement is required.
5. To define optimal negotiation strategies.
6. To consider training expert negotiators.

It is quite instructive to view the accomplishments of the first two years of the project in light of these objectives. As is perhaps often the case with exploratory research, our accomplishments were a result not only of work on these objectives, but also of new goals that emerged as the original objectives were followed.

Original objectives

Not all of the six original objectives were pursued with equal intensity. It became soon obvious that in order to test some of the assumptions of the model, several other assumptions had to be taken care of through experimental design. Thus instead of investigating the assumption that the probability of speaking remains fixed (Assumption

3), an experimental design was formulated in which the order of speaking was fixed and each negotiator had to speak whenever it was his turn. To facilitate the testing of the assumption that the impact of the speech depends on which proposal is endorsed (and not, for example, on who is endorsing it), an "abstract" design was utilized side-by-side with the "spoken" design: in the abstract design the negotiators' speeches were reduced to an endorsement of the proposal, while in the spoken design, the negotiator was allowed to say whatever else he wished.

Of the remaining objectives most effort went into determining the optimal strategies of negotiation. The analysis of the data showed that "toughness," as measured by the average requested payoff, was a crutial strategic variable: the subject who was tough (made few concessions and hence had a high average payoff) in the first experiment he participated in, was very likely to be tough also in the subsequent experiments; toughness was shown to be related to certain personality variables (see below); and toughness was strongly related to the outcome of the session. The main findings about the optimality of toughness as a strategy are shown below:

Groups Considered	r_{TA}	r_{TP}	N
Groups in which agreement was reached	--	.27	485
All groups	-.14	.07	648

Notice that toughness is an optimal strategy only in a qualified sense: if a session ended in an agreement, then those who were tough tended to receive high payoff (r_{TP} = .27). However, the sessions with tough negotiators tended to break down, as shown by the coefficient $r_{TA} = -.14$, thus indicating dysfunctional aspects of toughness. In fact, the data suggest that the "good" and the "bad" aspects of toughness tend to cancell each other out: when the zero payoff accruing to negotiators in case of nonagreement was taken into account, there was no significan relationship between toughness and payoff ($r_{TP} = .07$).

The timing of an endorsement was another strategic consideration given detailed attention. It was shown that our model of negotiation predicts that the most recent speeches carry most weight and the data fully supported this prediction. The strategic implication of this fact seems to be, among other things, that the negotiator who speaks last has the best chance of swinging the outcome his way and that, therefore, it may be worth his while to attempt to secure for himself the right of the last speech. The conclusion, incidentally, common-sensical as it may sound, is contrary to some social psychological work that hypothesizes that the first speech is most influential. The work concerning the recency effect is described in a forthcoming publication (see below).

In pursuing the second objective, it was found that the impact a speech has on a negotiator does not depend only on the payoff that the negotiator is promised, but also on the payoff that the opponent demands for himself. If negotiator's payoffs and those of his opponent are in conflict, then the negotiator tends to react to opponent's low offers by high demands and as opponent increases his offers, the negotiator lowers his demands. If, however, two negotiators are "natural allies" in the sense that their payoff functions are similar, then reverse relationship tends to hold: a high offer leads to to a high demand. Just how these findings can be best taken into account theoretically is being investigated at the time of writing.

The first objective of the project was pursued but differently than originally anticipated. The original intention was to test empirically the assumption that negotiators always try to maximize their expected utility. But it became clear that it is better to view this assumption as representing a point of view, a framework within which the negotiation process is understood and analyzed, rather than as an empirical proposition. Hence the procedure for testing this assumption became the development of alternative models of negotiation, models that do not make this assumption. In particular, several stochastic models and a model fashioned after Richardson's model of the arms race were formulated and are being tested (see below).

The last objective, the training of expert negotiators, was followed in two ways. First of all, it was observed that the participation in the experiments themselves did much to give the subjects certain degree of expertness, both as indicated by their introspective reports and by the fact that the session which was the second or third for the subjects was more likely to end in an agreement than their first session. Secondly, certain very simple strategies were developed and some subjects were instructed in their use. One of such strategies, for example, was the strategy of endorsing the proposal that was (unkown to the negotiators) the "fair" outcome of the session: a specially selected subject was instructed in some sessions to "push" that proposal in the early stages, while in another session he was instructed to push it in the late part of the session. The subjects experienced no difficulty in following such instructions.

New Objectives

As our experience with the model, the experiments, and the gathering of the data grew, some objectives that could not have been anticipated earlier began to emerge. Perhaps the most significant change in our plans was the shift from testing our model as a whole to testing it part by part, and to formulating alternative models.

As our work with the model proceeded, it soon became clear that the most crucial assumption was the assumption dealing with subjective probability:

(1) $$p_f^{(t+1)} = \alpha p_f^{(t)} + (1-\alpha)\lambda_f^{(t+1)}$$

where

(2) $$\lambda_f^{(t+1)} = \begin{cases} 1 \text{ if } f \text{ is endorsed at time } t+1 \\ 0 \text{ otherwise} \end{cases}$$

To test this assumption and to test it independently from the assumption that each subject maximises his expected utility (the product $v_f p_f^{(t)}$, where v_f is the subject's payoff associated with proposal f) a specific experimental design was developed. In this design one negotiator, unkown to the rest, played the role of a "mediator"; his payoff was the same for all proposals but it varied with time so that the earlier the session terminated, the more money he received. Thus the mediator was motivated to work for an early agreement, no matter what agreement it may happen to be. It is perhaps clear that the mediator was, according to our model, supposed always to maximise his subjective probability as given by the above equations.

To test whether the mediator actually behaves as specified by the above equations, the model was used to make predictions concerning the behavior of the mediator in subsequent rounds. And it was at this point that we discovered that the model implied the "recency effect," i.e., that the mediator will always have a bias towards endorsing the proposal that was last to be endorsed. As is shown in a forthcoming publication (see below), the mediators behaved precisely as predicted by the model, the recency effect was found to exist just as expected.

These findings gave full support to eq. (1) but eq. (2) was left untested, for values of λ other than those given in eq. (2) also imply the recency effect. In fact, evidence soon began to emerge suggesting that eq. (2) is not plausible. Of this evidence the strongest is the fact that with eq. (2) our model implies that negotiators will either agree on the proposal one of them prefers most at the beginning of the session, or else no agreement will be reached at all. This implication is implausible since it means that the negotiators do not make any concessions -- a result contrary to the very definition of negotiation. Consequently eq. (2) was modified so that λ_f became a function of the number of previous endorsements: the more often certain negotiator endorsed f prior to time t, the smaller was λ_f. In this fashion, repeated endorsements of the same proposal by the same negotiator were assumed to have a declining reinforcement value, until, if repeated often enough, they became negatively reinforcing. In other words, the new eq. (2) implied that after many repetitions the point is reached when further repetitions are viewed by opponents as an evidence that the repeatedly endorsed proposal will *not* be unanimously accepted, such endorsements cause the subjective probability p_f to decrease.

It was at this point that we decided that alternative models of negotiation should be formulated and explored. The reason was that we intended to create a simple model of negotiation, but the just described modification of eq. (2) made our model fairly complicated. Before we went into testing this more complex model, we felt, we should make certain that there are no simple alternatives. Furthermore, we were encountering some problems in testing our models. For example, it was difficult to decide what would be the best way in which the goodness of fit between the model and the data can be tested, since our model made predictions in terms of expected utility, a variable that cannot be measured empirically.

A new conception of negotiation began to emerge as a result of these considerations. As an alternative to our original model, we began to explore a model that views negotiation as consisting basically of two more-or-less distinct phases. The early phase is essentially a "reactive" process with the same formal properties as the Richardson's model of the arms race, the late phase a game in the von Neumann and Morgenstern sense.

The advantage of the new conception was that its adequacy was quite easy to test empirically and that, as a result, it proved to lead to considerable insights into negotiation itself. Richardson's model is formally equivalent to a multiple regression equation, and hence the coefficients of the model can be estimated quite easily by standard statistical procedures. The theoretical as well as the experimental work on the new model is in the beginning stages at the time of writing, but some promising results are already available. Preliminary analysis of the data suggests that a negotiator does not relate to all opponents in the same way, that he tends to relate to his "natural allies" in a different way than to his "natural opponents" (see above).

Parallel with these new theoretical interests, we developed a new practical interest: to what extent is it possible to predict the behavior of a negotiator from his personality traits? As was mentioned already, the degree of "toughness" emerged as an important strategic variable. Is it possible to predict the degree of toughness from existing personality questionnaires? The most significant results were obtained by using the California Personality Inventory:

Independent Variable	Dependent Variable: Toughness In		
	1st session	2nd session	3rd session
Self-control	-.16	-.27	-.21
Tolerance	-.15	-.23	-.20
Good Impression	-.18	-.16	-.15
Achievement via Conformity	-.09	-.36	-.29
Achievement via Independence	-.25	-.16	-.16
Intellectual Efficiency	-.10	-.25	-.10
Age	-.16	-.21	-.13
Toughness in 1st session	--	.32(.28*)	.28
Toughness in 2nd session	.32(.28*)	--	.50(.47*)
Toughness in 3rd session	.28	.50(47*)	--

*Partial coefficient of correlation

Although the above results are only preliminary, being based on only 93 subjects, certain interesting conclusions are suggested:

1. As mentioned above, the subject who is tough when he serves as a subject for the first time tends to be tough also when he serves the second and third time (coefficients .32, .28, and .50).
2. The tough subject has personality that would in our culture be evaluated as "undesirable." Tough subjects are neither socialised nor mature (first three rows), nor are they particularly "intelligent" (rows 4-6).
3. Although personality does have an effect upon the way a subject negotiates, learning in the experiments has an even stronger effect: the coefficients in the brackets (.28, .47) are partial coefficients, resulting after all the personality variables have been controlled for. The fact that these coefficients remain high suggests that learning alone accounts for much of the negotiating behavior. This conclusion is further supported by the fact that $R^2 = .16$ for the first session (when personality variables only are used to predict toughness), while for the second session(when toughness during the first session is also used) $R^2 = .29$, for the third session (when toughness during both the first and the second session is used) $R^2 = .35$.

Publications

The project and its results were highly publicised during the grant period. The principal investigator read a paper at the meetings of the Midwest Sociological Society in April of 1963 and at the meetings of the American Sociological Society in August of 1963. In addition, he taught a Summer Seminar at Princeton University (June 18 - July 27, 1962) and a Seminar on Mathematical Models at the Northwestern University (Spring 1963-4), the mathematical model of negotiation being a subject of extensive discussion on both occasions. Finally, the model was discussed at Faculty colloquia at the Northwestern University, University of Pittsburgh, and the University of Hawaii.

In addition to several manuscripts in progress, two papers were accepted for publication during the grant period:

Otomar J. Bartos, "A Model of Negotiation and the Recency Effect," *Sociometry*, Sept. 1964.

Otomar J. Bartos, "A Model of Negotiation and Some Experimental Evidence," in: F. Massarik and P. Ratoosh (Eds.), *Mathematical Explorations in Behavioral Science*, Homewood, Ill.,: R. D. Irwing & Co., 1964 (Fall)

Honolulu, Hawaii, July 20, 1964.

Otomar J. Bartos

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